

## **Exploring parents' experiences with standards-based mathematics curricula**

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### **Abstract**

Parents may have difficulties relating to mathematics curricula that focus on conceptual rather than procedural understanding (Remillard & Jackson, 2006) because such curricula engage students in activities that are different from those that students experienced in previous generations. We report on a case study that explored how parents make sense of conceptual-based curricula by engaging two parents with tasks from their children's curriculum. Our report details both the tasks with which we engaged the parents and their ways of thinking about mathematics that emerged as they interacted with those tasks. Our findings suggest that in some cases parents' previous experiences with their school mathematics interfered with their ability to make sense of the tasks in a manner consistent with the curriculum authors' intent. However, we also found that their previous experiences with informal mathematics could be leveraged to support their endeavour to make sense of tasks from a standards-based curriculum in a manner consistent with that intended by the curriculum authors. Nevertheless, we also believe that the school-based tasks used in the study encouraged parents to interpret their children's curricular materials in terms of their own experiences with school mathematics rather than in terms of their informal knowledge. This study contributes to researchers' understanding of the complex process of sense making that is necessary for parents (and adults in general) to relate to standards-based mathematics curricula, and it raises questions about how parents might be supported in that process.

**Key words:** Parental involvement; informal mathematics; standards-based curricula; mathematics reform

### **Introduction**

Recent reform documents, such as those published in the United States by the National Council of Teachers of Mathematics (National Council of Teachers of Mathematics, 1989, 2000) have called for a shift from a focus primarily on procedural knowledge of mathematics to one that includes conceptual understanding. This has prompted the development of new curricula (e.g. Lappan, Fey, Fitzgerald, Friel, & Phillips, 1996; TERC, 1998; University of Chicago School Mathematics Project, 2001). These curricula often engage students in instructional activities that

are different from those their parents experienced, thereby raising questions about parents' ability to make sense of them in the manner intended.

Romberg (1996), reflecting on mathematics curricula in the United States, notes that "The acquisition of information and the ability to demonstrate proficiency at a few skills have become ends in themselves, and students spend their time absorbing what others have done" (p. 763). For instance, thirty years ago students might have been given a sheet of 50 multiplication problems to solve. Curriculum authors justified this by observing that students need to know basic facts "that is, commit them to memory to the point of instant recall" (Shoecraft & Clukey, 1981, p. ix). To the contrary, in standards-based curricula<sup>1</sup> "how well children come to understand mathematical ideas is far more important than how many skills they acquire" (National Council of Teachers of Mathematics, 1989, p. 16). Students are encouraged to generate their own strategies for performing arithmetic computations based on their understanding of numbers and how numbers are composed and decomposed (Mokros, 2003). This is in stark contrast to the mathematics instruction experienced by many parents, instruction based on beliefs such as "finding  $7+8$  by counting on fingers or  $5\times 6$  by adding five sixes, although not horrible sins, are inadvisable" (Shoecraft & Clukey, 1981, p. ix).

Since the mathematics curricula parents experienced and those their children experience have different emphases, parents often experience difficulty making sense of their children's schoolwork and sometimes feel powerless to help their children with it (Remillard & Jackson, 2006). Since the context of school mathematics extends beyond the classroom and includes interactions with parents, guardians, and caretakers<sup>2</sup> at home, if standards-based curricula are to be effective, parents need to relate to and understand the intention of such curricula. This suggests that supports need to be created for and offered to parents so they can be constructively involved in their children's education. However, before helpful support for parents can be designed, the community needs to learn more about how parents presently experience standards-based curricula and what supports are most helpful to them.

In order to contribute to this understanding, we report on a study that explored ways in which parents interpret their children's school mathematics by considering two questions: (i) what experience do parents have with their children's school mathematics? and (ii) what sense do parents make of that mathematics? In particular, we will describe two different parents' experiences as they interact with their children's school curriculum.

In interpreting their children's curriculum, these parents drew both on their own school mathematics and on their informal mathematics. By *school mathematics* we mean the strategies they learned in school to solve mathematical problems, and by *informal mathematics* we mean strategies developed independent of classroom instruction. It is likely that the strategies the parents learned in school differ from those their children are learning in school. Consequently, the parents' school mathematics probably differs from that of their children. Informal mathematics includes strategies that are developed outside the context of school, as well as those that are developed in the school context but may not be considered appropriate strategies by the classroom teacher. Since a wider variety of strategies are accepted in schools today, it is possible that children's school mathematics might include strategies their parents consider to be informal.

The parents in our study initially experienced difficulty uncovering the nuances of the instructional activities largely because the intention of the tasks was different from that of the tasks with which they were familiar. Problems also arose for parents because they tended to use their knowledge of school mathematics rather than their informal knowledge of mathematics to

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<sup>1</sup> Standards-based curricula refers to curricula created based on the NCTM (1989, 2000) standards documents. .

<sup>2</sup> In the remainder of this paper we will use the word *parents* to describe all of these groups. .

make sense of their children's tasks. This likely happened because the problems they were considering were from a school context, that is, the context of their children's schooling. Ultimately, however, the parents were able to use their previous experiences from outside of the mathematics classroom to help them make sense of the activities with which their children engage in school.

In this paper, we first describe the study itself, including how the interview tasks were designed to uncover the parents' ideas about the tasks in their children's mathematics curriculum and to help the parents make sense of these types of tasks. We then describe the parents' experiences interacting with their children's mathematics curriculum during the interviews. Next, we explicitly discuss how previous experience and context played a role in the parents' sense making. Finally, we elaborate some implications of this research; namely, the ways in which engaging with their children's mathematics might empower parents with respect to their children's education and enable them to be more involved with the reform process.

## Background

The impetus for this study and the subsequent analysis of the data were informed by two major areas of inquiry: research on parental involvement and research on adult learning. There are various perspectives on parental involvement and what precisely is meant by this term (e.g. Lawson, 2003). Although the literature features a fair amount of discussion on the myriad of views, we will focus in particular on the research relating to parents experiences with standards-based curricula and parents as learners of mathematics. Similarly, there is a vast amount of research on adult learning, but we will focus on research related to the role of informal knowledge in learning mathematics, and issues related to context and transfer of that knowledge.

### Research on parental involvement

Research has found that parents have difficulty understanding tasks from standards-based curricula (Remillard & Jackson, 2006). A similar finding is reported in Peressini (1996; 1998) who describes parents as unequal participants in the discourse on reform in mathematics education. The ways in which mathematical knowledge influences parents' participation in their children's education has been examined as well (Civil, 2001a, 2001b; Civil, Guevara, & Allexaht-Snider, 2002; Peressini, 1998). For example, Peressini (1996) reports that, "Parents also voice apprehension regarding their inability to assist their children with these home activities" (p. 14). On the other hand, Martin (2006), who interviewed parents about their own and their children's experiences with school mathematics, uncovered that their "(re)investment in mathematics learning and (re)assuming the role as a mathematics learner can serve as the basis for meaningful parent agency and advocacy in mathematics education" (p. 202).

Civil and her colleagues have designed courses and workshops to engage parents with mathematics and have documented the impact of these courses on participants in terms of their role as parents. For example, Civil, Guevara, and Allexaht-Snider (2002) reported that parents appeared empowered by the mathematical understanding they constructed in these workshops. Also, parents who participated in these programs came to value meaning-making and sense-making in mathematics (Civil, 2001b; Civil et al., 2002).

We attempt to add to this literature by exploring ways in which parents experience their children's curriculum, how their previous experiences with mathematics impacts this experience, and how parents can be supported in their endeavour to learn from their children's curriculum. This study aims to extend the existing research that shows parents have a difficult time making sense of their children's curricula by taking a close look at the sense that parents *do* make of their children's mathematics. This study also builds on the research that shows that

mathematical knowledge affects how parents participate in their children's mathematics education by helping parents deepen their own mathematical knowledge in a way that will help them make sense of their children's mathematics. A meaningful interaction with tasks from their children's curriculum may help parents better understand the intention of the curriculum and, in turn, be better equipped to participate in their children's schooling.

### **Research on adult learning**

Another body of research examines the role of informal knowledge in learning mathematics. Informal knowledge has several related characterizations, but in most characterizations it is described in opposition to knowledge acquired in formal or academic settings (e.g. Torff & Sternberg, 1998).

#### ***The role of context***

Several researchers have examined the ways in which adults use informal mathematical knowledge in out-of-school contexts and how this knowledge transfers to a school context (e.g. Carraher & Schliemann, 2002; Schliemann & Acioly, 1989). For example, Schliemann and Acioly (1989) observed that bookies have well developed mental arithmetic skills and consistently performed computations with accuracy at work. The bookies used mental computational strategies and informal reasoning more frequently than procedures like those learned at school. Yet in the second phase of the study, the bookies were given problems that were slightly different than the problems they encounter at work. In one set of problems, the tasks were similar in structure but the numbers were not multiples of 5 and 10 (which was frequently the case in their work) and in these problems the bookies tended to use written algorithms. On the other hand, bookies were able to use informal strategies to find answers to problems that involved division, an operation for which many of the bookies had no procedural strategies. The context of the problem – either in terms of the familiarity of the numbers or in terms of the familiarity with the structure – determined whether the bookies relied on their informal knowledge or procedural knowledge of mathematics learned in school.

#### ***Transfer***

In a study of apprentice ironworkers' mathematical problem solving strategies, Martin, LaCroix, and Fownes (2006) consider an alternative to the problem of the transfer of knowledge. In keeping with Benn (1997) and Evans (2000), the problem of transfer is reconceived as *translation across discourses*, where a discourse is understood as "a loose-knit collection of concepts, terms, assumptions, explanatory principles, rules of argument and background knowledge which are shared amongst the members of that discourse community" (Benn, 1997, p. 96). Adults returning to school find the discourse of school mathematics unfamiliar, and they do not see the similarities between school mathematical knowledge and their own mathematical knowledge constructed in out-of-school contexts. Evans understands knowledge as being socially constructed within communities of practice and he believes that context is important for knowledge construction. Yet he argues that transfer across contexts *is* possible and that transfer can be facilitated by analyzing both the similarities and differences across contexts.

#### ***Resistance***

Another obstacle impeding the transfer of adults' informal knowledge to the context of school mathematics is resistance. Wedege and Evans (2006) observe that although adults develop mathematical competence through everyday activities, "their beliefs about mathematics are primarily related to their school experiences, and mathematics is experienced by many adults as something that others can do, but that they themselves cannot do" (p. 28). One of the resistances to learning mathematics described by Wedege and Evans is illustrated by the phrase

“Mathematics – that’s what I cannot do.” Wedege and Evan observe that adults often do not recognize their own knowledge as mathematical: “once people have succeeded in applying a piece of mathematics, it becomes *non-mathematics* or *common sense*...mathematics is always what they cannot do” (p. 34). Not recognizing the validity of their own informal mathematical knowledge is an issue for many adults. In the context of exploring parents’ understanding of tasks from their children’s mathematics curriculum, this resistance is used as an analytical lens for viewing how parents draw upon their formal and informal mathematical knowledge when working with their children on mathematical tasks.

Finally, Wedege (1999) highlights the complexity of studying adult learning within the context of mathematics education. Adults bring a variety of experiences to a mathematical task. Wedege notes that “The situation of learning mathematics depends on the experience of the individual adult with mathematics in school and everyday practice and their individual perspectives on learning. Emotional factors are just as important as cognitive ones” (p. 206). Adults who engage in mathematical tasks with their children also bring a variety of beliefs to the tasks; including their beliefs about mathematics, their beliefs about themselves as learners of mathematics, and their beliefs about their role as parents.

We draw on this body of research by considering the ways in which parents’ informal knowledge contributes or hinders their learning from their children’s curricula. In particular, we look at how parents draw on both their informal knowledge and their knowledge of school mathematics in their sense making. We consider the role of context, transfer, and beliefs in this process as well. In this way, we combine research on adult learning with research on parental involvement as a way to understand parents’ experiences with their children’s curricula and as a way to help empower parents with respect to their children’s mathematics education.

## The Study

In order to provide insight into the ways parents make sense of and learn from the standards-based curricula their children use, we describe a case study involving interviews with two parents. Our study was exploratory in that the goal was to understand better parents’ experiences and to use this information to inform future studies. In what follows we describe the parents who participated in the study as well as the interviews themselves.

### The participants

Two parents, Jorge and Michelle<sup>3</sup>, volunteered to participate in the study. Both parents have children in a dual-language (English and Spanish), urban elementary school. Jorge has three sons in the school. At the time of the study, his sons were in first, third, and fifth grade. Michelle had a son in first grade and a three-year old daughter. Both parents were interviewed separately while they tried to make sense of tasks based on components from their children’s curriculum. We developed these tasks from games, homework assignments, and parent resources included with the curriculum used at their children’s school.

Although the parents interviewed have children in the same school, they are quite different in other ways. Jorge works long hours in a warehouse, often working overtime. He tries to help his children with homework whenever he can, but his schedule makes that difficult. Jorge is bilingual, but he has only studied mathematics in English. His sons occasionally bring home mathematics problems written in Spanish, and Jorge finds this an additional challenge. Michelle is a stay-at-home mother who spends a large part of her days with her children and regularly helps her son with his homework.

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<sup>3</sup> Pseudonyms are used for the parents’ names.

Both parents believe it is important for their children to be successful in mathematics, but both are insecure in their abilities to help their children. Jorge is confident in his ability to do computations but not in his ability to solve other mathematical problems; he does, however, recognize that he uses mathematics at work. He also perceives his sons' school mathematics as more advanced than what he studied in school. Michelle did not express confidence in her mathematical ability in any way.

The parents were interviewed separately so the researchers could closely monitor and probe how the parents experienced the curricular materials. The interviews were divided into two parts, each of which was related to a particular theme. The first part of the interview highlighted the use of games for learning mathematics (in particular about how numbers can be broken apart and recombined); the second part of the interview focused on the teaching and learning of multiplication. Jorge participated in the two parts of the interview on separate occasions, while Michelle participated in both parts during one longer interview. All interviews were videotaped, and all written work was collected.

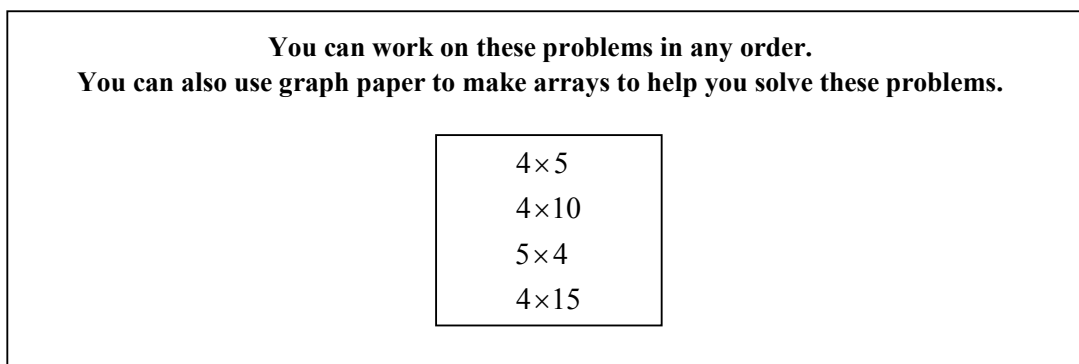
### **The interviews**

There were several goals for the interview. One goal was to see how parents responded to their children's assignments on their own with no intervention, just as they presumably would if their children brought the task home to complete. Another goal was to explore how we could support parents' sense making with respect to the mathematical materials their children use in school. These interviews were constructed around tasks from the curriculum used in their children's school, *Investigations in Number, Data and Space* (TERC, 1998). At the end of each of the two sets of interview questions described above, we gave the parents a copy of a letter that targeted one of the tasks used in that interview. Each unit of the curriculum contains a letter to be sent home to parents that elaborates the mathematics explored in that unit. These letters are from the teacher materials that accompany the curriculum.

The data that we report on in this paper are drawn from the second set of interview questions. These interview questions were based on *multiplication cluster* tasks from both the third- and fourth-grade materials. Multiplication cluster tasks suggest strategies for finding products using the distributive property of multiplication over addition. In what follows we discuss only the interview tasks that are relevant to the data we discussed in this paper.

### ***Multiplication clusters***

We began the second phase of the interview by showing each parent the problem displayed in Figure 1, which was taken directly from the books used at their children's school:



*Figure 1. Sample task from children's curriculum*

We asked the parents if they had ever seen problems like this before. We did this to learn what initial notions parents had about problems of this type and whether it was the first time they had ever seen such a problem.

We then asked the parents the following questions: (i) what, if any, relationship they saw between the problems in the cluster, (ii) if they could think of why this type of problem was called a multiplication cluster, (iii) how their children might use graph paper to solve the problem, and (iv) how the first three products on the page could be used to find the fourth product? These questions were designed to learn what sense parents made of problems such as these, and how they would attempt this particular problem if their children came home with it.

Next, we moved on to multiplication clusters involving the product of two two-digit numbers, which is how multiplication clusters appear in the fourth grade materials. The first cluster presented to the parents involved the product of  $36$  and  $20$ , the second the product of  $26$  and  $30$ , and the third the product of  $34$  and  $45$ . We anticipated that the parents would find the last of these problems difficult since neither of the factors is a multiple of  $10$ . So, as a follow up, we presented the following scenario to each parent:

Suppose you look through your child's math folder and find some figures your child had drawn in class for  $26 \times 34$ . What are these figures illustrating? How could you use a similar figure to help your child with the product of  $34$  and  $45$ ?

Figure 2 represents one of the drawings we showed them. Our aim was to explore how the parents made sense of their children's work and how they might go about applying the strategy used in their children's schoolwork to a new problem.

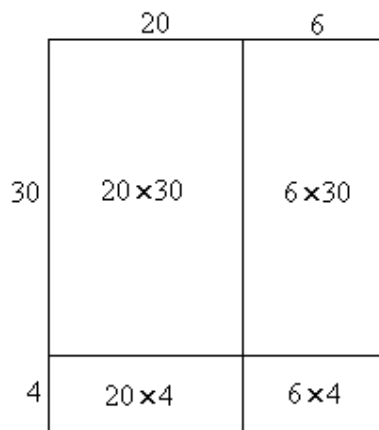


Figure 2. Model for multiplication allegedly discovered by the parent in the child's math folder.

### ***The standard algorithm***

The final task of the interviews involved the standard computational algorithm used in the United States for multiplication. We showed the parents two multiplication problems computed using this algorithm. However, each of the problems contained errors that are commonly made when the algorithm is used. These problems are shown in Figure 3 below:

$\begin{array}{r} 26 \\ \times 3 \\ \hline 38 \end{array}$	$\begin{array}{r} 45 \\ \times 23 \\ \hline 135 \\ +90 \\ \hline 225 \end{array}$
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Figure 3. Typical errors

The parents were asked to find the errors in the problems and to explain to us why they thought a child might have made those errors. Our aim was to explore parents' ideas about the standard algorithm. Another purpose for this question was to see how, in light of their experiences during the interview (in particular with multiplication cluster problems), parents might help their children, and specifically, how they might do so when standard procedures are involved. Consequently, we also asked the parents what they would say or do to help their child understand each of the problems shown above. In the end, we asked them why, in general, they thought people made errors like the ones shown above. We asked this to learn about the parents' beliefs about learning mathematics, as well as to explore how those ideas might have changed over the course of the interviews. Part of our goal here was to uncover what (if anything) these parents found problematic about teaching students algorithms without understanding the mathematical concepts behind them.

### **Data reduction and analysis**

The analysis proceeded in phases that were consistent with grounded theory (Strauss & Corbin, 1998). Once the interviews were transcribed they were viewed by each of the authors without interruption in order to capture a global view of the interviews. In this phase, each of the authors worked independently, looking for themes emerging within and between the interviews,



constantly comparing the themes to the data to test them for viability, and revising them based on that comparison.

In the second phase of analysis the authors compared the themes each generated during their independent analyses, looking for commonalities between the stories that emerged for each researcher. There was significant commonality between the themes identified by each researcher. The most salient themes for each related to the parents' use of formal and informal mathematical knowledge during the interviews and the tensions between the two forms of knowledge. Both researchers were also struck by the role of the parents' beliefs relating to mathematics, including phobia and self-doubt.

In what follows we discuss these themes in more detail. Since the goal of this research was to explore how parents make sense of their children's curricula, we first focused on each parent individually and then looked for commonalities and differences between the two. Accordingly, our analysis led us to compare instances throughout the interviews where each parents' sense making could be identified, and to compare the ways in which the parents made sense of the tasks. In the next section we discuss the stories that emerged from this research as a result of this multi-staged analysis.

## Findings

The main goal of the study is to explore how parents experience and make sense of their children's curricula. Our analysis of the interviews revealed that parents' previous experiences with mathematics played a large role in that process. Therefore, we begin by describing the two parents' experiences making sense of their children's mathematics in terms of their previous experiences with formal and informal mathematics. The parents drew on two sources of mathematical knowledge when they engaged with their children's mathematics: the first source is their own experiences with school mathematics (formal mathematics) and the second is an informal or everyday knowledge of mathematics that has developed within their out-of-school activities such as work, managing a household, and parenting. Additionally, we hypothesize that context influences which source of knowledge a parent draws upon in a given circumstance. Examples of each of these ideas follow.

### Prior experience with school mathematics

#### *Michelle*

Michelle's previous experiences with school mathematics affected how she engaged with the tasks. These experiences included both the emotions she experienced around her own school mathematics and the solution strategies she used in her schooling. For instance, her feelings about mathematics framed how she viewed her children's mathematics education. She mentioned several times during the interview that her experience with mathematics in school was not positive, and she expressed a genuine desire to nurture a more positive experience for her son.

M: I don't want my son to be afraid of math. You know... 'Cause I know that I was intimidated. I don't want him to be afraid of it. It needs to be something that's fun and challenging.

The first thing Michelle told us in her interview was how confusing she remembered school mathematics to be. At the beginning of the interview, she frequently began tasks by saying "I don't know," even though she often proceeded to reason successfully through the problem. She brought fear of mathematics and doubt about her mathematical ability to the interview with her.

In addition to viewing the new mathematical tasks through a perspective of insecurity and doubt rooted in her own school mathematics experiences, she brought other notions from those experiences to the interview tasks as well. Michelle also drew on mathematical strategies that she learned in school. For instance, this arose with the multiplication cluster problems. In multiplication cluster problems students are presented with four products to compute (for example, refer to Figure 1). The first three products can be used to compute the fourth because they suggest ways of breaking up the factors in the final product. To use these partial products to compute the fourth product, students implicitly rely on the distributive property of multiplication over addition. Although these problems are referred to as cluster problems in various places in the curriculum, the tasks themselves contain no reference to that language. Therefore, when multiplication cluster problems are taken home there is nothing to suggest the products are related except that they are presented together in one problem.

When we showed Michelle a multiplication cluster problem, she said she had seen problems like them before. However, since Michelle's son was in first grade at the time of the interview and multiplication cluster problems do not arise until later, it is unlikely she had actually seen multiplication clusters before. It is likely she felt she had seen similar problems before because she had seen multiplication problems and assumed this activity was no different than a worksheet of multiplication problems like those she had completed in school. Since this was her own experience with multiplication problems, there would be no reason for her to think multiplication cluster problems were any different than the problems she had seen in her own schooling. Consequently it is not surprising that Michelle interpreted the question differently than was intended by the curriculum authors.

The directions for the multiplication cluster problem mentioned using graph paper, so when Michelle explained that she had seen problems like the multiplication clusters before she added the caveat

M: not with the graph, not associated with a graph. I don't recall that. And I don't really recall how they broke it down to show us. I think it was probably, you know, five times four would be the, you know, four groups five times, is what I am guessing.

An interesting feature about this comment is that Michelle assumed the graph paper was for making a graph<sup>4</sup>. Since creating graphs was likely the only activity for which Michelle had used graph paper, it makes sense that she would assume this was the intention. However, Michelle did reflect on her own school experience and described an array model of multiplication, even if it did not immediately occur to her that graph paper could be used for that purpose. Therefore, although she had ideas that were consistent with the ones her son might use, she did not realize it because she interpreted the introduction of graph paper to mean that the students should draw a graph. In these ways, her previous experiences with school mathematics both helped her address the task in the manner intended and interfered with her ability to reason through her son's school mathematics. Thus, even when she recognized that the tasks from the curriculum used in her son's school represent a different way of looking at mathematics, her natural recourse was to view the task through the lens of her own school mathematics, an instinct that both helped and hindered her sense-making process.

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<sup>4</sup> This problem was taken directly from the curriculum used at the school Michelle and Jorge's children attended. The directions for this problem specified *graph* paper rather than *grid* paper, which might be problematic for parents attempting to interpret the intent of the task.

### *Jorge*

Jorge also used his experiences of school mathematics to frame his interactions with his sons' school mathematics. He described this in recounting a recent experience he had working on homework with one of his sons:

J: But I have... I do homework with the boys when I have a chance, like last night. I was doing work with [Vincent], one of my boys, and he's doing multiplication.

I: Cool.

J: And... his homework comes one way, but I was showing him different ways, with flash cards, and that route, because he's good at memory, and knowing his times table is important to do his homework.

Similarly, when Jorge was presented with a problem suggesting "use graph paper to make arrays to help you solve these problems," he explained that the graph paper could be used to "make a multiplication chart."

Additionally, like Michelle, Jorge said he had seen multiplication cluster problems before. However, when we asked what relationship he saw between the problems in the cluster he explained that "they are all multiplication." This, once again, raised the question of whether Jorge had in fact seen cluster problems before, or if he assumed all activities involving multiplication were the same.

We then told Jorge that the goal of multiplication clusters was to find the last product,  $4 \times 15$  in the case of our problem, and we asked if he could use other products in the cluster to find this product. The solution he described involved starting with the product  $4 \times 10$ , which was one of the products listed in the cluster. Next he used the standard algorithm from his schooling to find the product  $4 \times 15$  and used that answer to figure out what he needed to add to  $4 \times 10$  in order to find  $4 \times 15$ . In doing this, he had to add 20 to 40, but he did not, on his own, see the connection between the 20 he added and the  $4 \times 5$  in the multiplication cluster. Below is the conversation that occurred around this task:

J: Yeah, but it wouldn't relate to this. It's just, four times ten, if you knew what four times ten was, then add the remainder, and that's the answer.

I: So what would the remainder be?

J: Wait, I have to do this out first, four times ten is forty, and then there's five more, I'd have to add five to that, we'd do this first, that's sixty, so it would be twenty, if he gets this one right, it would be forty, and add twenty to that.

In sum, although Jorge could reason through this problem in the manner intended, it was not his primary method of solving the problem. Instead, he drew on his own knowledge of school mathematics in his initial approaches to problem. Later in the interview, the researcher pointed out to Jorge that he had arrived at the same result by reasoning through the problem as he had employing the algorithm from his schooling. He emphatically pointed to his work using the algorithm and said, "This is the way I know how... I keep referring to that."

In these examples, we observe that Jorge and Michelle often used their experience with school mathematics to make sense of their children's homework problems. At times the perspective of school mathematics made it difficult for them to make sense of the tasks in the intended manner, and yet at other times it helped them figure out a way to answer the questions being asked. Each parent's own experience with school mathematics played a prominent role in the sense-making processes.

## **Informal mathematics**

### ***Michelle***

Although the parents looked at their children's school mathematics through the lens of their own school mathematics, they also looked at it from the point of view of their experiences outside of the context of school. For instance, Michelle did this when she explained why it is important to find multiple solution strategies:

M: It gives them two different angles to look at something. And I think that's really important, because...our brains are formed a certain way, and through our experiences... I think it can be... some of us can be limited. I mean, it's just sometimes a natural thing. But I think that we've got to give them the ability to see problems from different perspectives.

In her own experience, Michelle had found value in the ability to solve problems using multiple strategies. She also stated that this is something students need to learn to do. Although this could be something that is learned in school, in Michelle's experience with school mathematics multiple strategies were not encouraged or valued. Therefore, her previous experiences outside of school mathematics helped her appreciate the reason her son's curriculum included activities that support the development of multiple strategies.

Michelle also drew on her experiences with informal mathematics while exploring the multiplication cluster problems. For example, when we asked Michelle to estimate a product, she reasoned through the calculation using partial products, determining the actual product rather than an estimate. We believe this was because, as she often expressed, in her experience standard algorithms were the tools used to determine the precise answers – the type of answers required in school. In school Michelle was not given the opportunity to reason through problems, so from her perspective reasoning was not part of her school mathematics experience. Consequently, she did not feel that reasoning led to precise answers; she considered results found through reasoning to be estimates rather than precise answers.

### ***Jorge***

Jorge also drew on informal mathematical knowledge to make sense of the tasks in his children's curriculum. For example, he drew on his informal understanding of area to approach several of the interview tasks. When we presented Jorge with a diagram of the product of 34 and 26 broken down into partial products (see Figure 2 for an example) and asked what was shown in the pictures, he immediately replied, "it might be a room, and then the dimensions, so 34 and 26 are the length and the other one [the width]." Typically, Jorge's initial responses were tentative; this was the first time he responded to one of our questions with confidence. He also elaborated on this idea:

J: They have it broken down, it's 26 all the way across, but they have it broken down, 10, 10, and then 6, but here they have all 34, and they broke it into 10 times 34, then on this one, they broke down the 30, then the 4, it's like a closet or something, and then a 20 by 30 room, it's a big space, and then here it's 20, then they've got 6 foot of something else.

He added that 26 times 34 represented "square footage" and then used the diagram to calculate the product by finding the area of each section of the room and adding them together to find the total area. In this case, the mathematics Jorge constructed outside the context of school was immediately available to him in the context of this particular problem. Jorge's informal knowledge of floor plans became a tool he used to make sense of the alternative strategies for multiplication in his son's curriculum. Furthermore, he seemed excited about being able to use his informal mathematical knowledge to solve school mathematics problems.

In sum, as was the case with their knowledge of school mathematics, the parents' familiarity with informal mathematics served as a lens for their sense making. Although this lens was not always readily available to parents in the school context, it helped them make sense of the tasks in the intended manner. It played a large role in the sense the parents made of the tasks.

### **The role of context**

We believe context determines which source of knowledge a parent draws upon. That is, the fact that the interview tasks were situated in the context of their children's schoolwork prompted both parents to draw on strategies from their own experiences with school mathematics. On the other hand, the parents felt more empowered to engage with problems posed in a context that drew on their everyday knowledge of mathematics (area models, money problems), but they did not always make the connections between their children's mathematical tasks and their own informal knowledge. In what follows we present evidence of this claim.

For example, using a floor-plan model empowered Jorge to engage with the multiplication cluster tasks in a way that he did not before this experience. Being presented with drawings that reminded him of floor plans gave him the context to draw on his informal knowledge. This is in contrast to tasks that reminded him more of the problems with which he was familiar from his own schooling.

Despite their sense-making experiences during the interviews, both parents immediately returned to their own school mathematics when a new problem was introduced. Near the end of the interview each parent was asked to interpret typical mistakes made by children when using a standard algorithm for multiplication (Figure 3). Although both Michelle and Jorge had made sense of alternate models for multiplication previously, they did not immediately draw on these experiences when analyzing the children's errors. It appeared that both parents' knowledge of the standard algorithms was procedural. In the course of the interview, Jorge experienced difficulty making connections between his new strategies for multiplication and the standard algorithm, but when prompted Michelle readily made such connections.

When we asked Michelle how she would help her son had he made the errors in our examples, her response was:

M: Well, if I did it the old-fashioned way... I'd say, "You missed the two." I'd say, whatever his marking might be here, but I'd say, "Okay, so you did that first... you came up with 18, and you carried the one over to this column. I'd break it up in columns so that he would see. [Drawing a line to separate the tens and units place of the given factors in the task] And then I'd say, "You need to have your one there. You need to multiply it by that..." And I'd even probably tell him, "Mark it off with your pencil so that you know what you need to do... so you can see where you have to go. So you see you multiply by this column first and then you come up to that number in the circle and then you add that one."

However, when we asked Michelle if there was anything from our interview she could use, she excitedly pointed to the multiplication cluster problems and the accompanying drawings. Nevertheless, even when she realized that the multiplication cluster problems could help her (and in what ways they could be useful), she made it clear that that would not be her first response. However, after expressing that caveat, she did use reasoning to talk about the algorithm.

M: Oh! I would use this [pointing to previous task papers]. Yeah... yeah...

I: Well, how would you use that?

M: Well...well, my automatic would be this [pointing to the pencil-and-paper strategy]. And then I'd go, "Okay. I got to go back to this thingy." So, I would break it to twenty... And I'd do it into this... [Michelle starts drawing an area model with four parts like those used for the two-digit multiplication, and explains how she would use her model to talk about the product being computed with the algorithm.]

Although Michelle was able to reason through the problems in the interview and constantly commented on how empowered she felt reasoning through mathematical tasks rather than using rote procedures, her initial reaction was to return to the algorithms and familiar strategies from her school mathematics. During the interview she frequently told us she would have immediately gone to the algorithm for most of these tasks had we not been there encouraging her to reason through them. The context of school mathematics constrained her perspective; in her experience, computing products using anything other than standard algorithms was not appropriate for school mathematics.

Jorge was able to make sense of many of the tasks in a way consistent with the curriculum authors' intention, and he was often more successful with the interview tasks when he reasoned through a solution than when he applied algorithms. Nevertheless, he continued to want to use algorithms to solve the tasks we presented him from his sons' curriculum. He explicitly stated this when he said, "this is the way I'm used to it, I keep referring to that." Even though he used other modes of solving problems, drawing on his out-of-school experiences with mathematics, he was not accustomed to reasoning in this way in the context of school mathematics; these methods seemed unfamiliar to him in this context.

For both parents, using their own informal reasoning was more effective than using standard procedures. Michelle was able to reason through multiplication problems and this reasoning helped her make sense of the procedures she previously learned in her own schooling. Jorge frequently made errors using computational procedures, but he obtained accurate results when using informal reasoning. Although informal reasoning was effective for both of the parents, the fact that the problems with which they were engaging were situated in a school context made school mathematics strategies and procedures the first recourse for each of them.

## Discussion

Throughout the interviews it was clear that the tasks and activities students engage in with standards-based curricula are quite different from those with which these parents engaged in their own schooling. In this study there was evidence that the parents' first instinct was to interpret their children's mathematics curriculum in terms of their experiences with school mathematics. A parent's first attempt to answer a question often involved using a standard algorithm from his or her own schooling. Although each parent was able to solve the problems using strategies more consistent with the curriculum authors' intention, they rarely drew on such strategies initially. Since the intention and purpose of the problems in standards-based curricula are quite different from those of their more traditional predecessors, interpreting new curricula in terms of old ideas means that the tasks and activities are likely to be interpreted in ways other than those intended by the curriculum authors. However, this research also suggests that drawing on knowledge derived from their own out-of-school experiences has the potential to help parents make sense of the tasks in a way that was compatible with the curriculum authors' intention. Therefore, in order for parents to make sense of their children's school mathematics, it is helpful for them to acknowledge that their own ways of thinking are valid within the context of school mathematics. That is, for parents to make sense of their children's curriculum

it is important to help the parents combine their informal knowledge with their knowledge of school mathematics and to help them realize it is appropriate to draw on both sources of knowledge in the context of school mathematics.

Several researchers who focus on adults learning mathematics (Benn, 1997; Wedege & Evans, 2006) have considered the problem of transfer of knowledge, such as transfer from the informal knowledge constructed in out-of-school contexts to the context of school mathematics. For these researchers the problem of transfer becomes one of translation across different contexts, a translation that starts with the recognition of similarities and differences between the different contexts. This lens is relevant here because in this work we are considering ways parents might translate their own informal mathematical understandings to the context of their children's standards-based school mathematics. This translation was an important component of Jorge and Michelle's sense making, but it was a non-trivial process for them.

The parents' own school mathematics often interfered with their ability to draw upon the entirety of their mathematical knowledge. Although it is not surprising that the parents drew upon their school mathematics, it is worth noting the extent to which their school mathematics hindered their ability to make sense of the tasks initially. On the other hand, when the parents were able to move beyond their school mathematics experience and draw upon their informal knowledge, they began to make sense of the tasks from their children's curriculum. If our goal is to help parents make sense of tasks from these curricula, then it is important to explore two things: first, the parents' perceptions of similarities between their own mathematical knowledge and the mathematical tasks in which their children engage in school; and second, their perceived differences that might hinder the parents' ability to make sense of their children's school mathematics. Furthermore, any course or resource designed to help parents understand the intention of the tasks from their children's school mathematics should build on parents' previous experiences as well as help parents use those experiences to relate to the tasks with which their children engage.

Finally, as Wedege (1996) observed, emotional factors to adults learning mathematics are just as important as cognitive factors. Michelle, who is competent mathematically, was strongly influenced by her own emotional experience with school mathematics. This was evident in Michelle's accounts of her own schooling, as well as the number of times she began working on a task by saying, "I don't know." Jorge brought a belief that school mathematics is predominantly about memorization and learning procedures. He made flash cards for his son and was emphatic that written procedures are "what I know." Any course or resource designed to help parents understand the intention of the tasks from their children's school mathematics should acknowledge and take into account parents' feelings and beliefs about school mathematics.

As Peressini (1996) observed, parents have historically been excluded from the discourse of mathematics education reforms. Dialoguing with parents about their experiences with mathematics both in school and in out-of-school contexts and harnessing these experiences might be one way for parents to relate to their children's school mathematics, allowing them to participate in the discourse of mathematics education reform.

## **Conclusion**

This exploratory study was designed to consider two questions: (i) what experience do parents have of the mathematics their children engage with in school? and (ii) what sense do parents make of that mathematics? Our report focused primarily on the second question. We observed that parents tend to draw upon their own experiences with school mathematics when interpreting the mathematics with which their children engage in school, but find a meaning

closer to the intent of the tasks when they draw upon their own informal knowledge constructed in out-of-school contexts.

Working with parents to help them understand tasks from a standards-based curriculum might be perceived as operating from a deficit model of parental involvement with their children's mathematics (Lawson, 2003; Peressini, 1996), but the parents in this exploratory study experienced a sense of empowerment as they constructed their own sources of mathematical knowledge and found this knowledge to be relevant within the context of their children's school mathematics. Additionally, for parents to be partners in their children's mathematics education and to participate in discussions surrounding it, it is necessary for parents to construct a new lens for viewing their children's school mathematics tasks, no longer viewing these tasks solely in terms of their own experiences with school mathematics.

In order to accomplish this, we should give parents access to the ideas that underlie reform in mathematics education and to help parents relate to the tasks their children engage with in school. This research suggests that building on parents' previous experiences with mathematics in and out of school contexts, and helping parents connect these two sources of knowledge, might be a productive place to start. Consequently, this research serves as a starting point for further research in this area. Research is needed to further develop our understanding of how parents make sense of these curricula, to gain insight into how parents connect their informal mathematics to their children's school mathematics, to explore further how context determines which source of mathematical knowledge a parent brings to her child's school mathematics, and to design and assess materials and activities that support parents in this process.

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